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Terminology in Underground Coal Gasification (UCG)

ICS 75.020

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Methods and Equipments for Underground Coal Gasification and Coal Bed Methane Sectional Committee, MED 37

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Methods and Equipments for Underground Coal Gasification and Coal Bed Methane Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard provides the details of various terms and processes used in Underground Coal Gasification (UCG). This standard is relevant and useful for students, research scholars, scientists, engineers and also for those interested in understanding the evolution and development processes in the field of underground coal gasification.

The composition of the Committee responsible for the formulation of this standard is given at Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

TERMINOLOGY IN UNDERGROUND COAL GASIFICATION (UCG)

1 SCOPE

UCG refers to gasifying *in-situ* a coal seam under controlled combustion and bringing the resulting synthetic gas (syngas) to the surface. The syngas is a mixture of hydrogen, carbon monoxide, methane, carbon dioxide (CO_2) and higher hydrocarbons. This standard provides the details of various terms and processes used in Underground Coal Gasification.

> **NOTE** — The referred standard is compilation of similar definitions for terminology/abbreviations as highlighted above, covering areas related to: - geology, reservoir, drilling, gasification, subsidence and extraction processes.

2 TERMINOLOGY

2.1 Aquifer — A body of rock whose fluid saturation, porosity and permeability permit production of ground water.

2.2 Coal — A carbon-rich sedimentary rock that forms from the remains of plants deposited as peat in swampy environments. Burial and increase in temperature bring about physical and chemical changes called coalification. Because of the organic origin of coal, it cannot be classified as a mineral. The main types of coal, anthracite, bituminous coal and lignite, can be distinguished by their hardness and energy content, which are affected by their organic content as well as their conditions of formation. Natural gas associated with coal, called coal gas or coalbed methane, can be produced economically from coal beds in some areas. In some basins coals form source rocks.

2.2.1 *Coal Combustion Waste* **—** Coal combustion wastes contain a variety of toxic compounds such as ash arsenic, cadmium, chromium, cobalt, lead, mercury, selenium, thorium and uranium, as well as dioxins and poly-aromatic hydrocarbons (PAHs) and flue-gas desulphurization products.

2.2.2 *Coal Seam* **—** Coal is found in sedimentary rocks as layers and beds which are known as seams.

2.2.3 *Combustion* **—** It is the sequence of exothermic chemical reactions between a fuel and an oxidant accompanied by the production of heat and conversion of chemical species. The release of heat can produce light in the form of either glowing or a flame.

2.3 Crip Technology — A “controlled retractable injection point” (CRIP) is a point where coiled tubing burns through the horizontal tunnel borehole casing; oxygen and steam are forced through the point to ignite the coal. The injection tube is to be retracted back as the coal is consumed, to ensure maximal usage of the coal in the seam.

2.4 Enhanced Oil Recovery (EOR) — It is a generic term for techniques for increasing the amount of crude oil that can be extracted from an; oil field. Enhanced oil recovery is also called **improved oil recovery** or **tertiary recovery** (as opposed to primary and secondary recovery).

2.5 Gasification — Gasification is a process that converts carbonaceous materials such as coal, petroleum coke, residue and/or biomass in presence of air/oxygen and steam, into synthesis gas (syngas) in which major components are hydrogen and carbon monoxide.

2.6 Ground Water Contamination — Groundwater contamination has been a major problem in almost all pilot UCG projects. The combustion of coal traps a variety of toxic substances such as mercury, phenol, and benzene into the former coal seam. Additionally, the solubility of heavy metals in water can be increased if the coal seam is fully oxidized. Pollutants can leach out through the surrounding rock or be taken up water that enters the chamber.

2.7 Horizontal Drilling — A subset of the more general term “directional drilling,” used where the departure of the wellbore from vertical exceeds about 80 degrees. Note that some horizontal wells are designed such that after reaching true 90 degree horizontal, the wellbore may start drilling upward. In such cases, the angle past 90 degrees is continued, as in 95 degrees, rather than reporting it as deviation from vertical, which would then be 85 degrees. Because a horizontal well typically penetrates a greater length of the reservoir, it can offer significant production improvement over a vertical well.

2.8 H/C (Hydrogen/Carbon) Ratio — Combustion energetics can be estimated from the bond energies for all the classifications of fossil fuels.

The amount of energy released is dependent on the oxidation state of the carbons in the hydrocarbon which is related to the hydrogen/carbon ratio. The more hydrogen per carbon, the lower the oxidation state and the more energy that will be released during the oxidation reaction. Thus, the greater the H/C ratio, the more energy release on combustion.

2.9 Hydrostatic Pressure — The normal, predicted pressure for a given depth or the pressure exerted per unit area by a column of freshwater from sea level to a given depth. Abnormally low pressure might occur in areas where fluids have been drained, such as a depleted hydrocarbon reservoir. Abnormally high pressure might occur in areas where burial of water-filled sediments by an impermeable sediment such as clay was so rapid that fluids could not escape, and the pore pressure increased with deeper burial.

2.10 In Situ Combustion — A method of thermal recovery in which fire is generated inside the reservoir by injecting a gas containing oxygen, such as air. A special heater in the well ignites the oil in the reservoir and starts a fire

2.11 Injection Well — A well in which fluids are injected rather than produced, the primary objective typically being to maintain reservoir pressure. Two main types of injection are common: Gas, and water. Separated gas from production wells or possibly imported gas may be re-injected into the upper gas section of the reservoir. Water-injection wells are common offshore, where filtered and treated seawater is injected into a lower water-bearing section of the reservoir.

2.12 Mercury — Mercury is released into the air from the combustion of coal. This mercury accumulates and concentrates in the food chain, where it is ingested by people (often through eating fish). Mercury is a toxic chemical that can affect the nervous system, immune system, and reproductive system, and is especially damaging to developing foetuses.

2.13 Overburden — Rock overlying an area or point of interest in the sub- surface. UCG is expected to be practiced on coal seams that are surrounded by impermeable and mechanically strong rock layers/ overburden.

2.14 Oxidant — An **oxidizing agent** (also **oxidant**, **oxidizer** or **oxidiser**) is the element or compound in an oxidation-reduction (redox) reaction that accepts an electron from another species. Because the oxidizing agent is gaining electrons (and is thus often called an **electron acceptor**), it is said to have been reduced.

2.15 Permeability — The ability, or measurement of a rock's ability, to transmit fluids, typically measured in Darcie's or millidarcies.

2.16 Phenol — Phenol, also known as carbolic acid and phenic acid, is an organic compound with the chemical formula C_6H_5OH. It is a white crystalline solid at room temperature. The molecule consists of a phenyl group ($-C_6H_5$) bonded to a hydroxyl group (-OH). It is mildly acidic but requires careful handling due to its propensity to cause burns.

2.17 Porosity — Porosity can be generated by the development of fractures, in which case it is called fracture porosity. Effective porosity is the interconnected pore volume in a rock that contributes to fluid flow in a reservoir. It excludes isolated pores. Total porosity is the total void space in the rock whether or not it contributes to fluid flow. Thus, effective porosity is typically less than total porosity.

2.18 Producing Well — A well producing fluids (gas, oil or water).

2.19 Proximate Analysis of Coal — The parameters of proximate analysis are moisture, volatile matter, ash, and fixed carbon. There are ASTM standards for analyses of coal that ought to be used.

2.20 Subsidence — Subsedence occurs when the ground sinks or collapses over an area where mining has occurred. Subsidence is inevitable with UCG because the supporting coal layer is being burned and removed as gases, leaving only residual ash and a void. However, most UCG projects propose to gasify coal seams that are deep enough to be inaccessible to conventional mining, and therefore the subsidence at the surface may be minimal and spread out. This deep subsidence may be subtle or invisible on the surface but could change patterns of groundwater flow.

2.21 SYNGAS — Syngas (*synthesis gas*) is the name given to a gas mixture that contains varying amounts of carbon monoxide and hydrogen.

2.22 Ultimate Analysis of Coal — Elemental or ultimate analysis encompasses the quantitative determination of carbon, hydrogen, nitrogen, sulfur and oxygen within the coal. There are ASTM standards for analyses of coal that ought to be used.

2.23 Underground Coal Gasification — Underground Coal Gasification (UCG) is an industrial process, which converts coal into product gas. UCG is an in-situ gasification process carried out in non-mined coal seams using injection of oxidants and bringing the product gas to surface through production wells drilled from the surface.

ANNEX A

(*Foreword*)

Organization(s)	*Representative(s)*
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BHEL, Hyderabad	Shri D. Satya Mohan Rao
Central Fuel Reasearch Institute, Dhanbad (CFRI)	Dr Ashok Kumar Singh
Central Mechanical Engineering Research Institute (CMERI)	Dr P. K. Chaterjee Dr M. K. Karmakar (*Alternate*)
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Directorate General Of Hydrocarbons (DGH)	Shri Sanjeeb Goswami Shri T. Ashwini Kumar (*Alternate*)
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Great Eastern Energy Corporation Limited (GEECL)	Shri Anoop Gupta Shri Priyaranjan Patra (*Alternate*)
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Neyveli Lignite Coporation (NLC)	Shri K. Alagar Shri M. Krishnan (*Alternate*)
IIT, Madras	Prof Srinivas Jayanti Prof Preeti Aghalayam (*Alternate*)
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In Personal Capacity	Shri Rudra Pratap Singh

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